THE SAN MATEO COASTSIDE REGIONAL OUTFALL

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Abstract

California's Clean Water Grant Program has had a significant impact on most wastewater treatment and disposal projects undertaken in the State in recent years. Program requirements have lengthened the time required from inception to completion of many projects, frequently have influenced standards imposed by local regulatory agencies, and often had profound effects on design and construction. This paper traces the 11-year evolution of an ocean outfall project which is part of a grant-funded regional wastewater system being constructed by three California coastside communities.

Introduction

In 1972, three California communities located adjacent to Half Moon Bay on the San Mateo County Coastline began planning for a regional wastewater treatment and ocean disposal system. The City of Half Moon Bay, the Montara Sanitary District and the Granada Sanitary District formed a regional wastewater management agency which became the Sewer Authority Mid-Coastside (SAM). As indicated on Figure 1, the resulting project is located approximately 20 miles (32.2 km) south of the entrance to San Francisco Bay.

The Montara Sanitary District, located immediately north of Half Moon Bay, shares a common boundary to the south with the Granada Sanitary District. The Granada Sanitary District and the City of Half Moon Bay also have contiguous service areas and are located adjacent to the northerly and southerly ends (respectively) of Half Moon Bay. In 1972, the estimated population of the combined service area was 10,200 people (1) with each agency maintaining separate treatment and disposal systems.

Existing Systems

The Montara Sanitary District operated a secondary treatment system with a 12-inch (30.5 cm) diameter outfall

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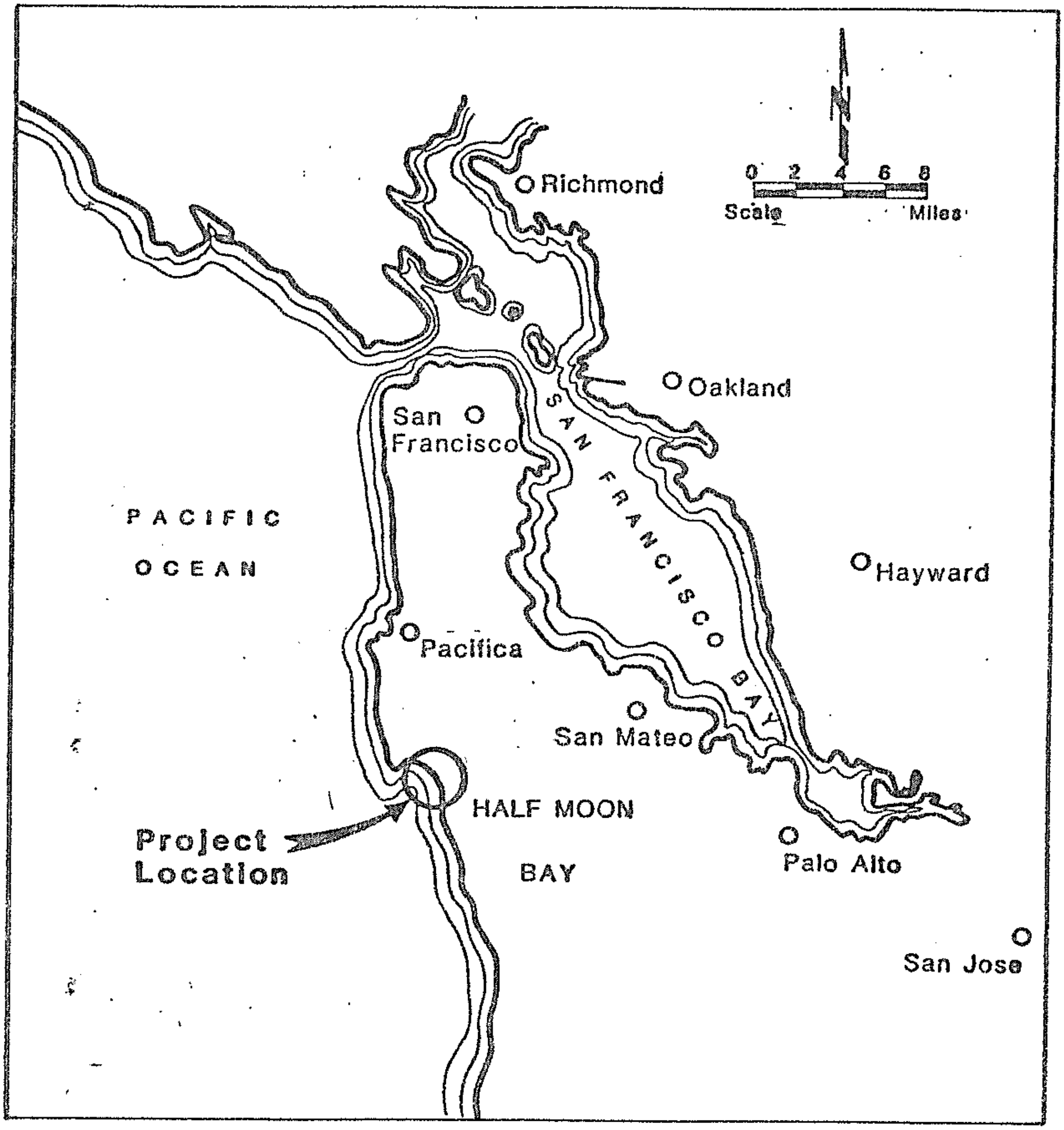

FIG. 1 -Location Map

extending 30 feet (9.14 m) offshore at Pillar Point and discharging about 7 feet (2.13 m) below mean sea level. The Granada Sanitary District operated a primary treatment facility discharging about 300 feet offshore through a 12-inch (30.5 cm) diameter outfall at a depth of approximately 5 feet (1.52 m) below mean sea level. Both systems discharged into shallow rocky areas which became part of the James V. Fitzgerald Marine Reserve.

In 1973 the City began construction of interim facilities; upgrading their primary treatment facility to provide secondary treatment, extending their outfall and adding a new multiport diffuser to provide an initial dilution of 100:1 at the point of discharge. The City's original outfall was installed in the late 1950's and had a history of breaking in the surf zone attributed to wave forces and shallow burial. On several occasions prior to 1976 the city had to make costly emergency repairs to the outfall (2).

The City's original 12-inch (30.5 cm) diameter welded steel outfall was extended with ductile iron pipe to a distance of about 1,600 feet (0.487 km) into Half Moon Bay. Also added was a 187 foot (57.7 m) ductile iron diffuser section with 35 ports, 1.5-inches (3.81 cm) in diameter, discharging at a depth of 30 feet (9.14 m) below mean sea level.

Regional Planning

The regional agency retained the engineering consortium of Barrett, Harris & Associates, Black & Beatch, and Resources Engineering & Management to provide planning, design and engineering services during construction. An extensive oceanographic study was done by Oceanographic Services Incorporated (OSI) to provide a basis for selection of an ocean outfall location.

The project report (4) completed in 1975 identified a number of alternatives for regional wastewater collection, treatment and disposal. The selected alternative called for consolidation of the regional treatment facilities at the site of the existing Half Moon Bay Treatment Plant; supported by an intertie system consisting of interceptor sewers and pumping stations, and an upgrading of the City's existing outfall system.

Project Setting

Half Moon Bay is a crescent-shaped open coastal area protected from severe sea conditions by Pillar Point Promontary to the north and to some extent by a shallow submerged reef system. (Refer to Figure 2). Pillar Point Harbor, located at the north end of the Bay, serves as mooring facility and launching area. As the only improved harbor along the Coast between Bodega Bay and Santa Cruz, Half Moon Bay's harbor provides an important refuge for mariners during inclement weather.

The Bay, which is approximately one mile (1.61 km) wide at its center, is bounded on the east by sandy beaches and

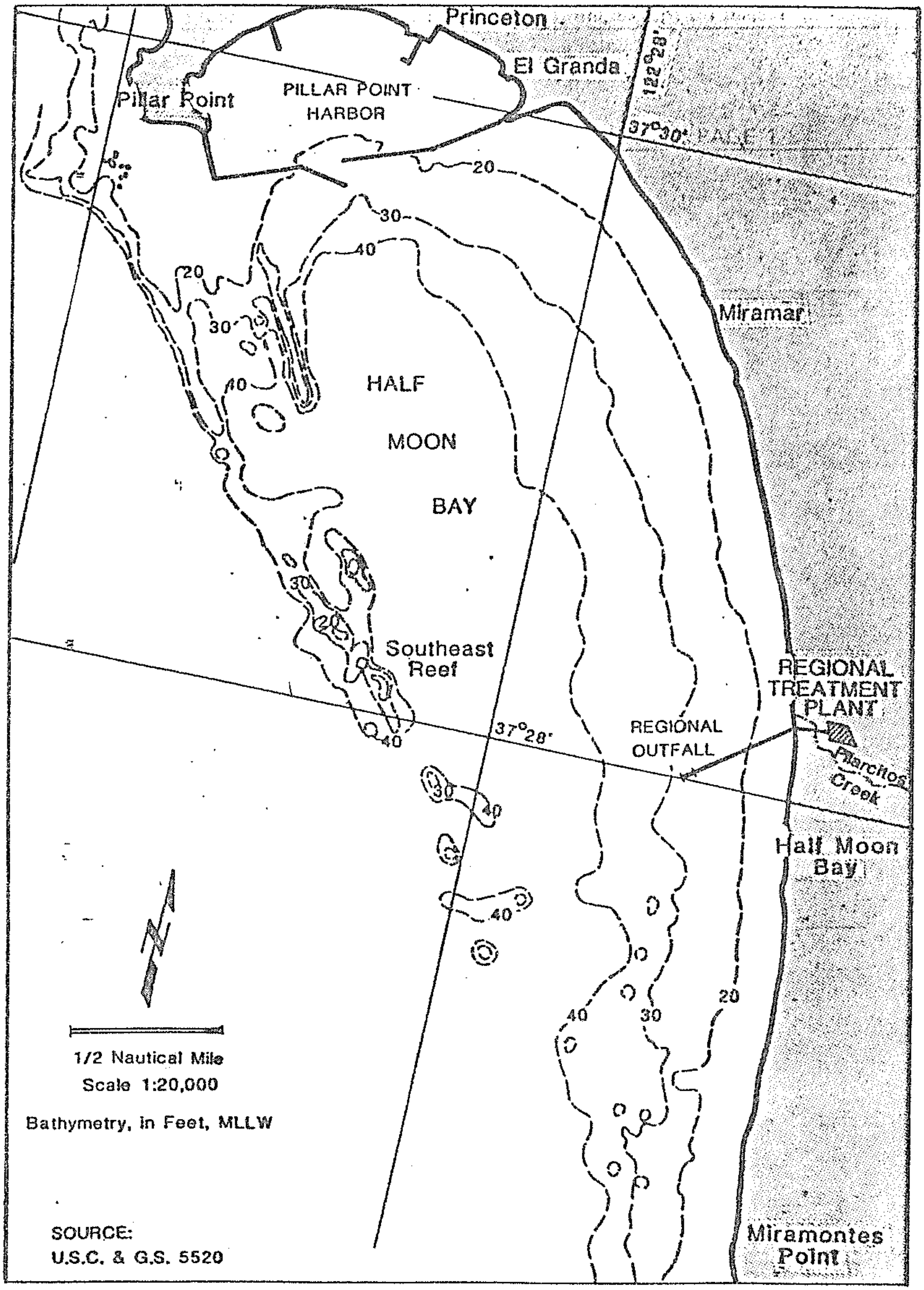

FIG. 2 -Vicinity Map

isolated from deep offshore waters to the west by the reef. The reef extends south parallel to the shoreline from Pillar Point towards Miramontes Point with an opening at the south end of the Bay. The reef is shallow but submerged along most of its length and is attributed to uplift on the western side of the Seal Cove Fault.

The Bay slopes gently to the west to a depth of about 65 feet (19.8 m) adjacent to the reef. The OSI report (3) indicates that sediments on the floor of the Bay are fine sand or shell fragments on the sloping areas with predominately hard mudstone (compacted silt) over the reef area. The southern most quarter of the Bay, near Miramontes Point, is accentuated by numerous rock outcroppings with variations in bottom elevation of from 4 to 10 feet (1.22 to 3.05 m). Reportedly no thermocline is present within the Bay.

Design Criteria

The "Water Quality Control Plan for the Ocean Waters of California", adopted by the State Water Resources Control Board (SWRCB) in 1972, restricted ocean discharges within the 30-foot (9.14 m) depth contour or 1,000 feet (0.308 km) of the shoreline, whichever is the greater distance from shoreline. The Ocean Plan further provided that bacteriological objectives, as determined by coliform concentrations, must be maintained throughout the water column in zones used for body-contact sports.

Actual discharge requirements issued by the Regional Water Quality Control Board include secondary treatment, a median receiving water coliform concentration not to exceed an MPN (most probable number) of 240 organisms per 100 milliliters, zero chlorine residual and a minimum 100:1 initial dilution at the point of discharge.

Because of the extensive recreational usage of Half Moon Bay Beaches, final design criteria was established in cooperation with the SWRCB Design Section after lengthy analysis of projected bacterial concentrations resulting from physical dilution only (ie: initial and transport dilution) without consideration of bacterial decay or disinfection. The agreed upon criteria included construction of an outfall extending 1400 feet (0.427 km) from shoreline and sufficient backup chlorination equipment to insure continuous compliance with disinfection standards.

Outfall Design

Design of the regional outfall system was completed in 1976. The system was to include a new 18-inch (45.7 cm) diameter outfall, to operate in conjunction with the City's existing outfall, and new effluent pumping facilities. The new outfall was to extend 1460 feet (0.445 km) from the maximum reach of shoreline at extreme lower low water to maintain a 30 foot (9.14 m) water depth for discharge. The pipeline was to terminate in a 161 foot (49.1 m) long diffuser section with 24 ports, 2-inches (5.08 cm) in diameter, and spaced on 7 foot (2.13 m) centers.

The new effluent pumping station was to be located adjacent to the regional treatment facilities inside a flood protection dike surrounding the existing treatment plant. The design called for the outfall to extend under the dike and Pilarcitos Creek to the new surge chamber located in the sand dune area. From the surge chamber, the outfall extends across the beach and into the bay. A bore and jacked casing was used to extend the outfall under the dike and anchors, precast on the pipe sections, were used for the crossing underneath Pilarcitos Creek to prevent flotation and movement.

The pumping facilities were designed for use under peak flow conditions only, thus when pumping is required the outfall will convert from gravity to pressure flow. Air trapped by the conversion to pressure flow will escape through an air and vacuum valve mounted on top of the surge chamber.

Outfall Redesign

As a result of a capacity dispute between the regional authority and State regulatory agencies, the regional project was "shelved" in 1977.

In 1978, the City of Half Moon Bay's outfall pipeline suffered a failure in the surf zone rendering the pipeline useless without extensive and costly repairs. Failure of the City's outfall ultimately led to a revival of the regional project. The new outfall pipeline was redesigned to convey the entire capacity of the regional treatment facilities.

The regional outfall is centrally located in the Bay extending across an exposed beach with an active surf zone. The beach experiences a seasonal inshore-offshore sand movement common to open coast beaches. Storm waves erode the beach sand veneer during the winter months transporting the sand offshore and depositing it as sand bars. During the summer months the reverse phenomenon occurs reshaping the beach profiles. Evidence of a 5 to 8 foot (1.52 to 2.44 m) change in Half Moon Bay beach profile during a single year has been reported (5).

The original design for the regional outfall system called for pipe burial in sand at a depth believed to be just below the anticipated seasonal movement of beach veneer. Based on observations by local residents of a clay or "mud" underlying the sand veneer in the surf zone, further soil investigations during 1978 resulted in an increase in the pipe burial depth to extend into the non-eroded "clay" strata. Other related design changes included a graded granular bedding and backfill material with a 30-inch (76.2 cm) thickness of "Armor" rock, a concrete weight coat to provide a negative buoyance of 20 pounds per linear foot (29.8 kg/m) and the specification of 600 feet (0.182 km) of temporary sheet pile cofferdam through the surf zone for protection during pipe installation.

As a result of the capacity increase to provide for a peak design flow of 5.4 million gallons per day (0.237 m /s); the pipeline diameter was increased to 20-inch (50.8 cm) with 237 feet (72.2 m) of diffuser section extending approximately 2000 feet (0.610 km) offshore and into 30 feet (9.14 m) of water (MSL).

Initial Construction Project

Because of litigation brought by the State seeking to enjoin the member agencies of SAM to complete the regional project on a stringent schedule, SAM elected to bid the construction contract specifying a six-month completion.

A public opening of construction bids was held in May of 1979. However, one of the unsuccessful bidders filed a formal protest delaying award to the low bidder until the end of July 1979.

The low bidder, who proposed the use of an unconventional construction method, was not an established marine contractor but had previous outfall construction experience. The contractor intended to fabricate a mobile working platform (referred to by the contractor as a "tower") intended for use on all surf zone and offshore construction activities.

The tower was a welded frame structure fabricated from large diameter steel pipe which supported a platform elevated approximately 65 feet (19.8 m) above the bottom of the structure. The platform and frame were mounted on two large (8 feet x 9 feet x 110 feet/2.44 m x 2.74 m x 361 m) pontoons. The pontoons were designed to be filled with air by compressors (mounted on the top platform) to increase buoyancy when the tower was to be moved. When flooded, the pontoons would rest on the ocean floor providing stable operating conditions for the 100 ton (90.2 Mg) crane mounted on the top platform.

The tower was designed to advance only forward or backward in a straight line. The contractor set sea anchors offshore of the diffuser tied off to two wire ropes, 2-inches (5.08 cm) in diameter, that extended through the tower back to the beach. The tower was advanced along the wire ropes by wire clamps attached to hydraulic rams.

The contractor apparently intended to fabricate and assemble the tower offsite, however, shortly after award of the contract the contractor revised his plan and began construction on-site. The on-site construction necessitated moving the tower, when assembled, from the staging area across the beach to the surf.

The contractor apparently underestimated the time and manpower required to construct the tower resulting in the loss of the 1979 construction season. Upon completion of the tower construction in late Spring of 1980, the contractor began advancing the tower across the beach installing sheetpiling for the pipe trench shoring. Unfortunately, the force necessary to move the tower across the sand was also underestimated; causing further delay which was compounded by the Summer advancement of the beach.

In late September of 1980, the tower advanced sufficiently into the surf zone to utilize the buoyance of the pontoons, greatly increasing its mobility. However, storm waves in October of 1980 immobilized the tower in the surf zone requiring the contractor to construct a trestle for access and to modify the tower design. Shortly after modifications were completed the tower was disabled following a December 1980 storm requiring further extension of the contractors trestle. The contractor was unable to make repairs until June of 1981.

The contractor elected to use restrained joint ductile iron pipe (class 56) which had been specified as an alternate to welded steel pipe. The contractor constructed special forms to pour the 2-inch (5.08 cm) concrete pipe coating on-site.

During the Spring and Summer of 1981 the contractor began installing pipe in the surf zone from the trestle. Shoring problems were encountered in the surf zone and in September of 1981 SAM was notified that the contractor was unable to continue. The contractor constructed the pumping station, the surge chamber, and installed 1025 feet (0.312 km) of pipeline extending about 175 feet (53.3 m) into the surf.

Offshore Construction

A second construction contract for completion of the outfall was awarded to the Healy Tibbitts Construction Company in June of 1982. The contract required testing of existing work, installation of 1930 feet (0.588 km) of submerged pipeline and diffuser, and removal of existing temporary structures remaining from the previous construction. The contract specified a one-year construction period.

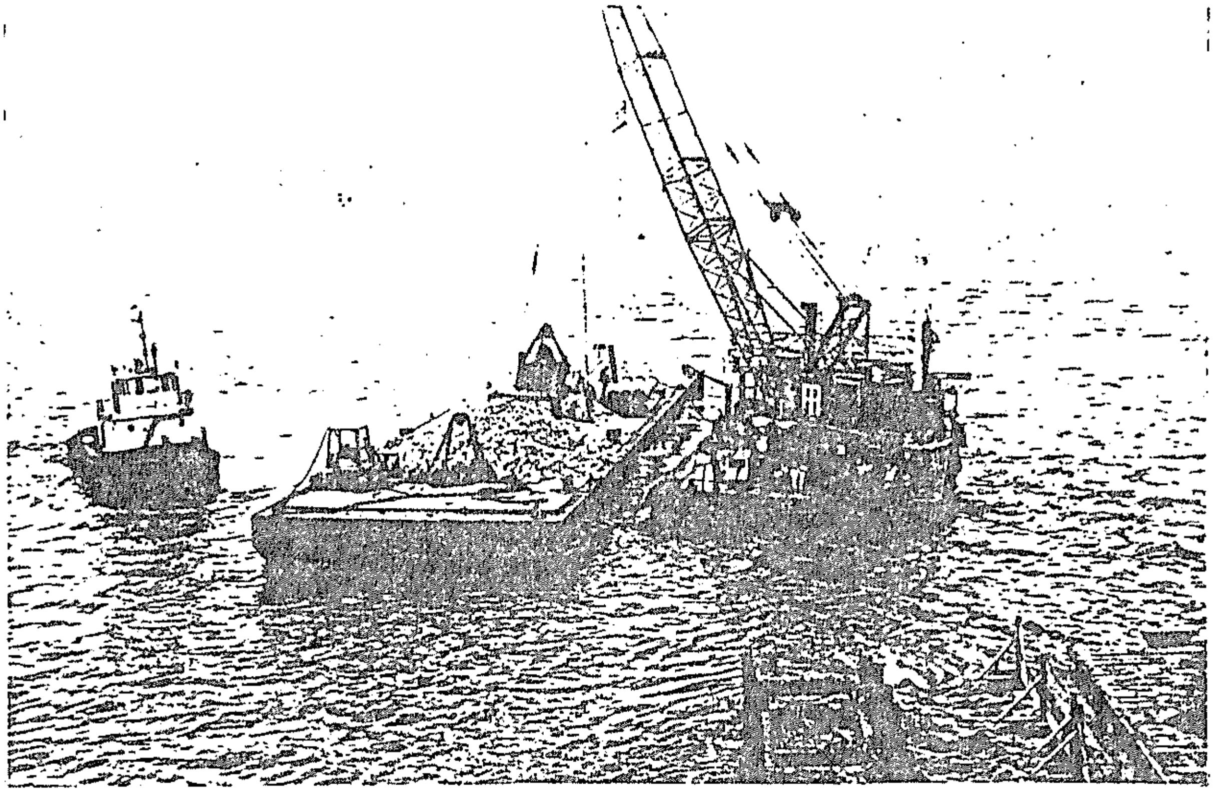

FIG. 3 -Derrick Barge Placing Armor Rock over an Offshore Pipe Section

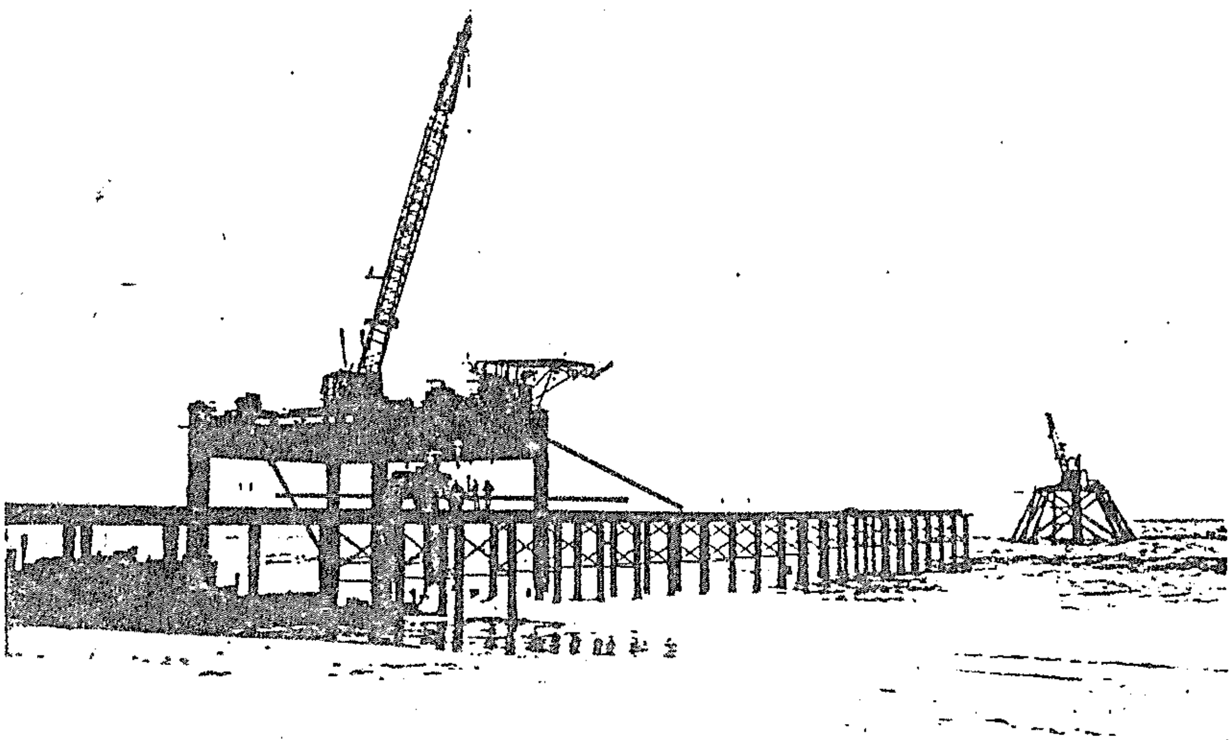

FIG. 4 -The Spider II Shown Adjacent to the Trestle with the Tower Located Offshore

Healy Tibbitts elected to use cranes working from the existing 700 foot (213 m) long trestle to install sheeting and pipeline through the surf zone. A derrick barge (refer to Figure 3) and hydraulic pipe horse are being utilized for pipe installation offshore of the trestle. Additionally, Healy Tibbitts has used the Spider II (a mobile working platform - refer to Figure 4) to assist with construction work in the surf zone.

The contractor elected to lay pipe in both directions from the offshore end of the trestle, necessitating a special (closure) coupling on the inshore connection to previously installed pipe. Offshore, the pipe horse was used to place two 18-foot (5.49 m) pipe sections at the same time.

Placement of diffuser sections was accomplished in two steps because the horse could not accomodate the 9 foot (2.74 m) riser spools (for the discharge ports) when mounted on the diffuser sections. To overcome this problem, an intermediate set of flanges was fitted at midpoint of the spools roughly corresponding to the top of trench (i.e.; the ocean floor) so that the top half of the spool could be installed separately. The location of the intermediate joint also provided the opportunity to make the riser section extending above the ocean floor a "breakaway" section to limit potential diffuser damage. This was accomplished by securing the flanged joint with polyvinyl chloride (pvc) bolts.

Healy Tibbitts installed 1550 feet (472 m) of outfall pipeline between mid-August 1982 and mid-January 1983. During the Fall of 1982, construction was slowed by the unseasonal frequency of storm activity and the discovery of a mudstone outcropping extending into the pipe trench along the last 700 feet (213 m) of offshore pipe excavation. The contractor used the impact generated by dropping a heavy pointed H-beam (referred to as a chisel by the contractor) to break up the mudstone sufficiently to allow excavation with a clam bucket.

In January of 1983, weather conditions caused the contractor to discontinue operations for the duration of the stormy season. The current schedule calls for startup of operations in mid-April and final completion by the end of August 1983.

Appendix I. - References

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KEY WORDS:

Ocean Outfall; Regional Project; Design; Construction Methods; Half Moon Bay; California;